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TUNNELING MICROSCOPY OF SUPERCONDUCTORS AND TUNNELING BARRIERS

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PROF. ALEX DE LOZANNE

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HIGH TEMPERATURE SUPERCONDUCTIVITY  
THIN FILMS, TUNNELING

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

At Westinghouse R. Silver built a cold stage for in-situ UPS measurements. Preliminary results show a fermi edge that disappears as the sample is warmed up in a vacuum. This surface degradation is reversible by annealing at 400C in pure oxygen.

The films made by co-evaporation at the U. of Texas have improved. Films on bare silicon have zero resistance by 73K. The best films grow on SrTiO<sub>3</sub>(110) with zero resistance by 84K and critical current densities greater than 10<sup>6</sup>A/cm<sup>2</sup> below 67K. These films have been characterized by in-situ low-temperature scan ; yielded, for the first time, good image mic measurements indicate thus far that most few spots showing superconductive be

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ANNUAL REPORT  
 GRANT # AFOSR-87-0228  
 PI: Alex de Lozanne  
 University of Texas at Austin

Program Manager: Dr. Harold Weinstock

**SUMMARY**

During this period we have concentrated on the characterization of YBCO films made by sputtering at Westinghouse and by co-evaporation at the University of Texas.

At Westinghouse R. Silver built a cold stage for in-situ UPS measurements. Great care was taken to prevent the loss of oxygen from the surface of the freshly made samples. Preliminary results show a fermi edge that disappears as the sample is warmed up in a vacuum. This surface degradation is reversible by annealing at 400C in pure oxygen. Details are given in publication (1) (copies attached).

The films made by co-evaporation at the U. of Texas have improved. Films on bare silicon have zero resistance by 73K. The best films grow on SrTiO<sub>3</sub>(110) with zero resistance by 84K and critical current densities greater than 10<sup>6</sup>A/cm<sup>2</sup> below 67K. Details are given in publication (35) (copy attached).

At UT we have also implemented a unique system of loadlocks that allows us to transfer a film from the synthesis chamber to the low temperature STM for analysis. This has yielded, for the first time, good images of the YBCO surface. Spectroscopic measurements indicate thus far that most of the surface is normal, with a few spots showing superconducting behavior and a large superconducting gap. Details are given in publications 27,28,29,31,32 (copy attached).

**PUBLICATIONS ACKNOWLEDGING SUPPORT FROM THIS GRANT**

\* = INVITED

- 1) "Preparation and Characterization of Superconducting Surfaces in HTS"  
 G.R. Wagner, R.M. Silver, J. Talvacchio, J.R. Gavalier, and A.J. Panson, Proc. 2nd Workshop on High Temperature Superconducting Electron Devices, June 7-9, 1989, Hokkaido, Japan
- 22) "As-deposited Superconducting Y-Ba-Cu-O Thin Films on Si, Al<sub>2</sub>O<sub>3</sub> and SrTiO<sub>3</sub> Substrates"  
 R.M. Silver, A.B. Berezin, M. Wendman and A.L. de Lozanne, Appl. Phys. Lett., **52**, 2174 (1988).

- 25) "Properties of In-situ Superconducting Thin Films of Y-Ba-Cu-O on Si, Al<sub>2</sub>O<sub>3</sub>, and SrTiO<sub>3</sub> Substrates"  
R.M. Silver, A.B. Berezin, E. Ogawa, and A.L. de Lozanne  
Proceedings, Applied Superconductivity Conf., Aug.  
1984, San Francisco, CA. IEEE Trans. Magn. **MAG-25**, 2526  
(1989).
- \*27) "Properties of Y-Ba-Cu-O Thin Films Grown In-Situ at Low Temperatures by Co-Evaporation and Plasma Oxidation"  
A.L. de Lozanne, E. Ogawa, R.M. Silver, A.B. Berezin, and S. Pan, Proc. Conf. Science and Technol. of Thin Film Supercond., Nov 14-18, 1988, Colorado Springs, CO. To be published by Plenum Press.
- \*28) "Thin films of Y-Ba-Cu-O grown in-situ at low temperatures by co-evaporation and plasma oxidation"  
A.L. de Lozanne, A.B. Berezin, S. Pan, R.M. Silver, and E. Ogawa, Proc. X Winter Meeting on Low Temp. Phys., Jan 15-18, 1989, Morelos, Mexico. (World Scientific. Pub., New Jersey, 1988) To appear.
- \*29) "Scanning tunneling microscopy of thin films of high temperature superconductors".  
Alex de Lozanne  
Mod. Phys. Lett. B 3, Feb. 1989 (World Scientific. Pub., New Jersey, 1989)
- \*31) "Thin films of Y-Ba-Cu-O grown in-situ at low temperatures by co-evaporation and plasma oxidation"  
A.L. de Lozanne, Proc. Tsukuba Seminar on High T<sub>c</sub> Superconductivity, May 31-June 2, 1989, Tsukuba, Ibaraki, Japan
- \*32) "Low Temperature Synthesis of Y-Ba-Cu-O Thin Films"  
A.L. de Lozanne, A.B. Berezin, S. Pan, R.M. Silver, and E. Ogawa, Proc. 2nd Workshop on High Temperature Superconducting Electron Devices, June 7-9, 1989, Hokkaido, Japan
- \*33) "Synthesis and Characterization of Thin films of High Temperature Superconductors"  
Alex de Lozanne  
Proc. SAMPE Third Annual Electronic Mat. and Proc. Conf., June 20-22, 1989, Los Angeles, CA.
- 35) "Thin Films of Y-Ba-Cu-O Grown In-Situ by Co-Evaporation and Plasma Oxidation"  
A.B. Berezin, E. Ogawa, S. Pan, R.M. Silver, and A.L. de Lozanne, Proc. Mat. & Mech. Supercond. Conf., Stanford, CA, July 24-28, 1989. W. Harrison, N. Phillips, and R. Shelton, eds., Physica C (North Holland)

### PROFESSIONAL STAFF

- 1) Supported by this grant:  
Richard M. Silver, graduate student
- 2) Not supported by this grant  
Alan Berezin, graduate student  
Ennis Ogawa, graduate student  
Logan Brashear, undergraduate student  
Prof. Alex de Lozanne, Principal Investigator

### INTERACTIONS

Oral presentations on the synthesis of high temperature superconducting films and on tunneling into these materials were given as follows (\* = INVITED):

- 1)\* Stanford University, June 10, 1988
- 2) Scanning Tunneling Microscopy Internat. Conf., Oxford, UK, July 4, 1988
- 3)\* Austin Summerfest, Austin, TX, Aug. 6, 1988
- 4) Applied Superconductivity Conf., San Francisco, Aug. 25, 1988
- 5)\* ASM meeting, Houston, TX, Oct. 4, 1988.
- 6)\* MRS/ISHM (Int. Soc. Hybrid Microelectr.), Dallas, TX, Oct. 5, 1988.
- 7)\* Electrochemical Soc. Meet., Chicago, IL, Oct. 11, 1988.
- 8)\* Conf. Science and Technol. of Thin Film Supercond. (SERI), Colorado Springs, CO, Nov 16, 1988.
- 9)\* Yale University, March 8, 1989
- 10) March Meeting of the American Physical Society, Saint Louis, MO, March 20-24, 1988 (Two talks)
- 11)\* MCC (Microelectr. & Comp. Tech. Corp), April 7, 1989
- 12)\* Meeting of the International Society for Hybrid Materials, April 12, 1988, Dallas, TX.
- 13)\* Tsukuba University, Japan, June 1, 1989
- 14)\* ETL (Electrotechnical Lab.) Japan, June 2, 1989
- 15)\* SAMPE (Soc. Advancement in Materials and Process Eng.), Los Angeles, June 21, 1989
- 16)\* NEC (Nippon Electric Co.) Tsukuba, Japan, July 7, 1989

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